Space Weather Technical Forecast

Issued on Thursday 12 December 2024 at 12:03 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: R1/R2 Likely.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Activity measured at GOES16 has remained Moderate, peaking with an M6.7 flare at 11/1549UTC from departed region Ex-AR3912 which is now nearing 110W.

There are now up to five sunspot regions on the disc, with an unnumbered new small bipolar region having developed in the southeastern quadrant. The two main sunspot groups at present are AR3917 in the southwest and AR3920 in the north-central part of the disc. Both regions have shown recent penumbral growth in their central portions, however in AR3920 this was also coupled with some shearing forward of one of the main central spots. A tentative Mt Wilson delta is perhaps visible in AR3917, with any in AR3920 perhaps now separating.

Two small filaments lifted off the disc almost in tandem at 12/0930UTC - firstly the far northern end of the series of filaments along 060W (at 15N), and secondly from near S20W040 - with imagery for both pending. With this possible exception, no Earth-directed CMEs were observed in the period, with activity generally confined to the far side (with far-sided halo CME activity probably related to Ex-AR3905/6, perhaps of note in roughly a week's time).

Solar Wind / Geomagnetic Activity: Solar winds, as reported by ACE at L1 showed an ongoing slow regime. The solar wind speed showed a slight decline within Background levels from near-400km/s to 350. The solar wind density rose over the same interval in single-figures ppcc (Background). The IMF was also at long-term Background with a stable trend and a peak of 6nT, with the north-south component erratic between limits of +4 and -5nT. Finally, the phi angle was positive (away from the Sun) throughout.

The net result of the above solar wind measures was provisionally Quiet geomagnetic activity throughout.

Energetic Particles / Solar Radiation: High energy proton flux observed by GOES18 was at Background levels, despite the M6 flare from a nominally prone location.

High energy electron flux (greater than 2MeV) observed by GOES16 showed a diurnal variation from Normal Background to Moderate levels, peaking at 802pfu at 11/1610UTC. The associated 24-hour fluence was below Active, with the 12/0001UTC observation being 2.27e7 integrated pfu.

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Four-Day Space Weather Forecast Summary

Solar Activity: Isolated M-class flares are Likely throughout the period, with a Slight Chance of X-class flares.

Solar Wind / Geomagnetic Activity: There are no confirmed Earth-directed CMEs, with haloes identified on coronagraph imagery tied to the far side.

Slow wind conditions are now expected until CH99's onset, with this most likely on Day 3 into Day 4 (between the UTC weekend days - 14 into 15 December). Geomagnetic activity is expected to start mostly Quiet as a result, rising to Active with a Slight Chance of G1 upon connection to CH99.

Energetic Particles / Solar Radiation: High energy proton flux is expected to remain at Background with a Slight Chance of rising in response to any notable flares.

High energy electron flux is expected to persist at Normal Background to Moderate levels at first, probably falling at GEO over the UTC weekend in the response to any inbound fast wind. The 24-hour fluence is expected to remain below the Active threshold.

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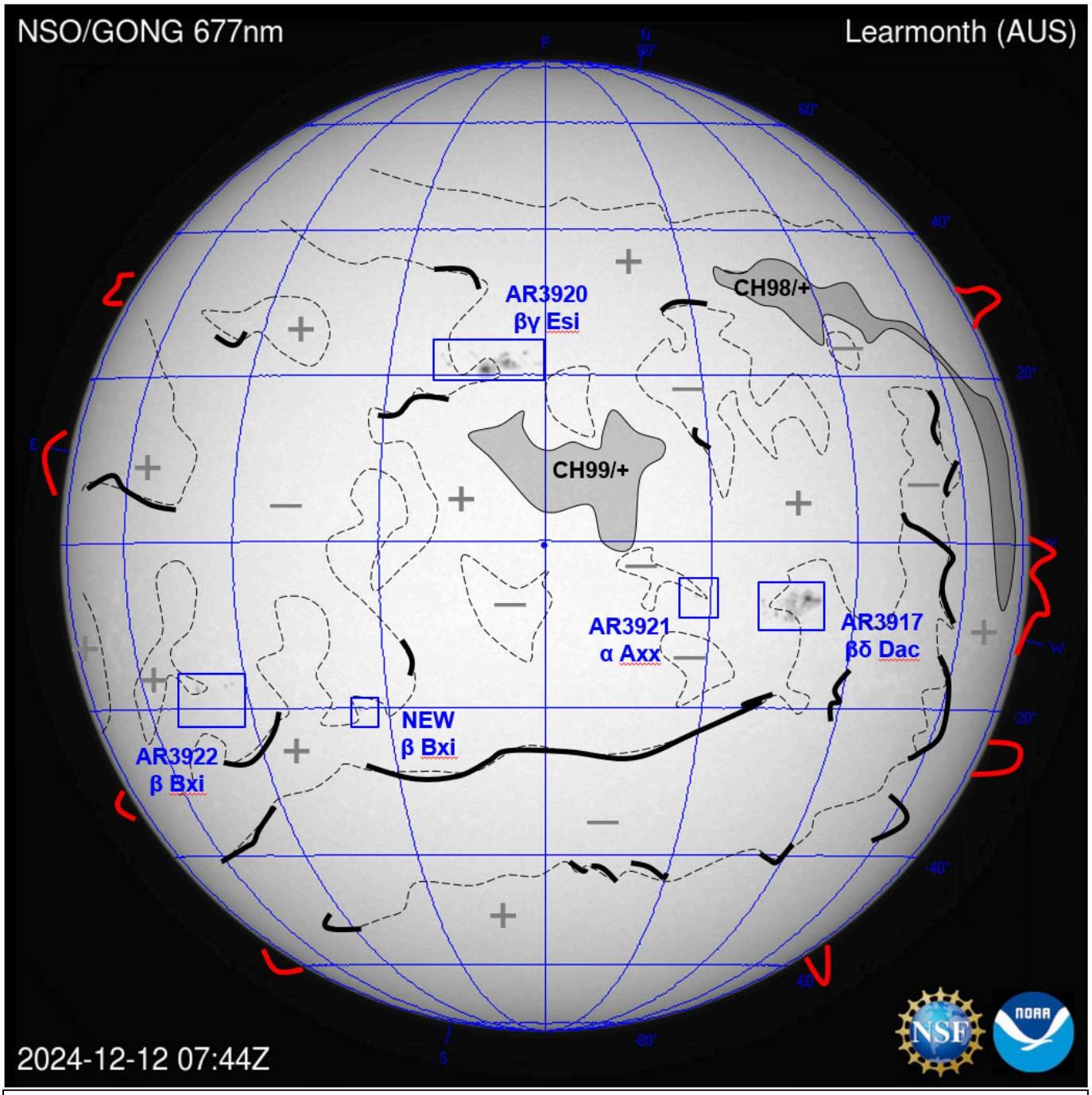
Figure 1: Solar synoptic map, valid 12/0745Z



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

No Earth-directed CMEs were observed in the period, with activity generally confined to the far side (with far-sided halo CME activity probably related to Ex-AR3905/6, perhaps of note in roughly a week's time).

In terms of potential progenitors of activity (as well as the larger sunspot regions), the front side harbours two generally contiguous large filaments - firstly along 60W and secondly spanning roughly 50 degrees of the central-disc between 20 and 30S. The former was quite mobile in the period (and in fact the northernmost portion lifted off at 12/0930UTC - any CME TBC) and was a poor match for its underlying magnetic neutral line in imagery, being relatively elevated from the 'surface' and potentially more likely to erupt. The southern hemisphere in general is starkly polarised in magnetic imagery in ongoing contrast to the northern solar hemisphere, which as a rule has remained generally less productive so far in the solar cycle.

Coronal hole-wise, Earth now finds itself transiting a sector of space characterised by a slow regime. While recent CH98 extends eastward across the northern disc, any further connection is likely to be minimal, bringing a now greatly-diminished chance of brief periods of slightly elevated solar winds. The next enhancement is expected from the fast winds of CH99, which is currently crossing the solar meridian. This is a persistent feature, and was likely the cause of a weak enhancement that occurred on the previous rotation on 18 November. This resulted in winds speeds of around 450km/s, and would map to this rotation to give an arrival on Day 4 (Sunday 15 December) and perhaps earlier if a stronger fast wind is observed. This being said, with the slightly elevated winds from CH99's previous rotation, there was little impact on the geomagnetic activity.

Enlil is currently showing a weak enhancement on 14 December, which is currently believed to be too quick in connecting to the HSS from CH99. Enlil also suggests Earth will continue to see a weak connection to CH98 for much of the period, which is not agreeing with current observations, leading overall to low model forecast confidence.

Overall, geomagnetic activity is expected to start mostly Quiet, rising to Active with a Slight Chance of G1 upon connection to CH99 between the UTC weekend.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	**G1 to G2**	No	1	1	5	5
Strong	**G3**	No	1	1	1	1
Severe	**G4**	No	1	1	1	1
Extreme	**G5**	No	1	1	1	1

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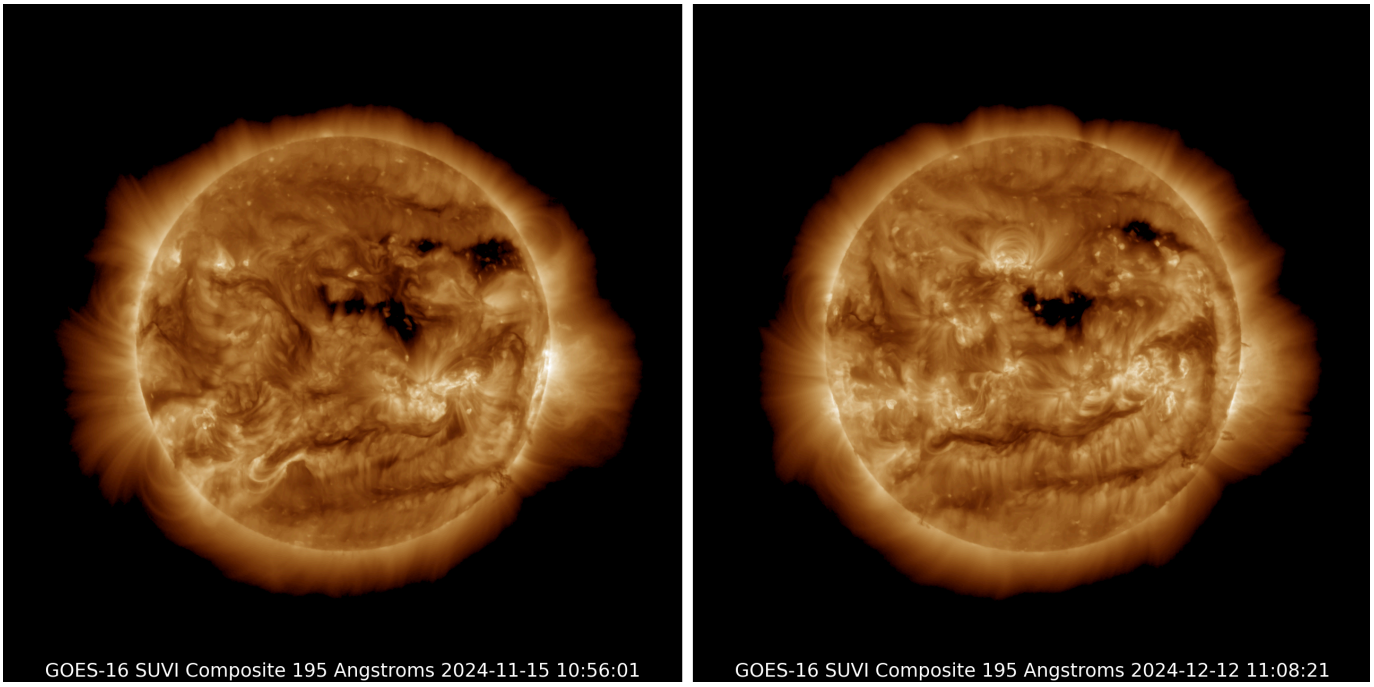
Figure 2: GOES16 SUVI 195 imagery for past and current rotations showing broadly similar geometry of CH98 (northwest) and CH99 (centre).



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Radio Blackouts - X-Ray Flares

The current Earth-facing disc is relatively sparsely populated at present, with Ex-AR3612 proving to be the most active sunspot region of the past 24 hours. There does remain some potential on the disc however, with AR3917 and AR3920 both large and complex regions. In terms of future trends, notable magnetic looping remains over southeast limb, with perhaps Ex-AR3899 and Ex-AR3901 expected around the limb into the coming UTC weekend. Both of these groups produced notable flares on their previous outing, although the extent to which they have survived remains to be seen.

All considered, isolated Moderate-class flares are Likely throughout the period, with a Slight Chance of X-class flares.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	Yes	60	60	65	65
Very Active	R3-R5 (X Class)	No	5	5	5	5

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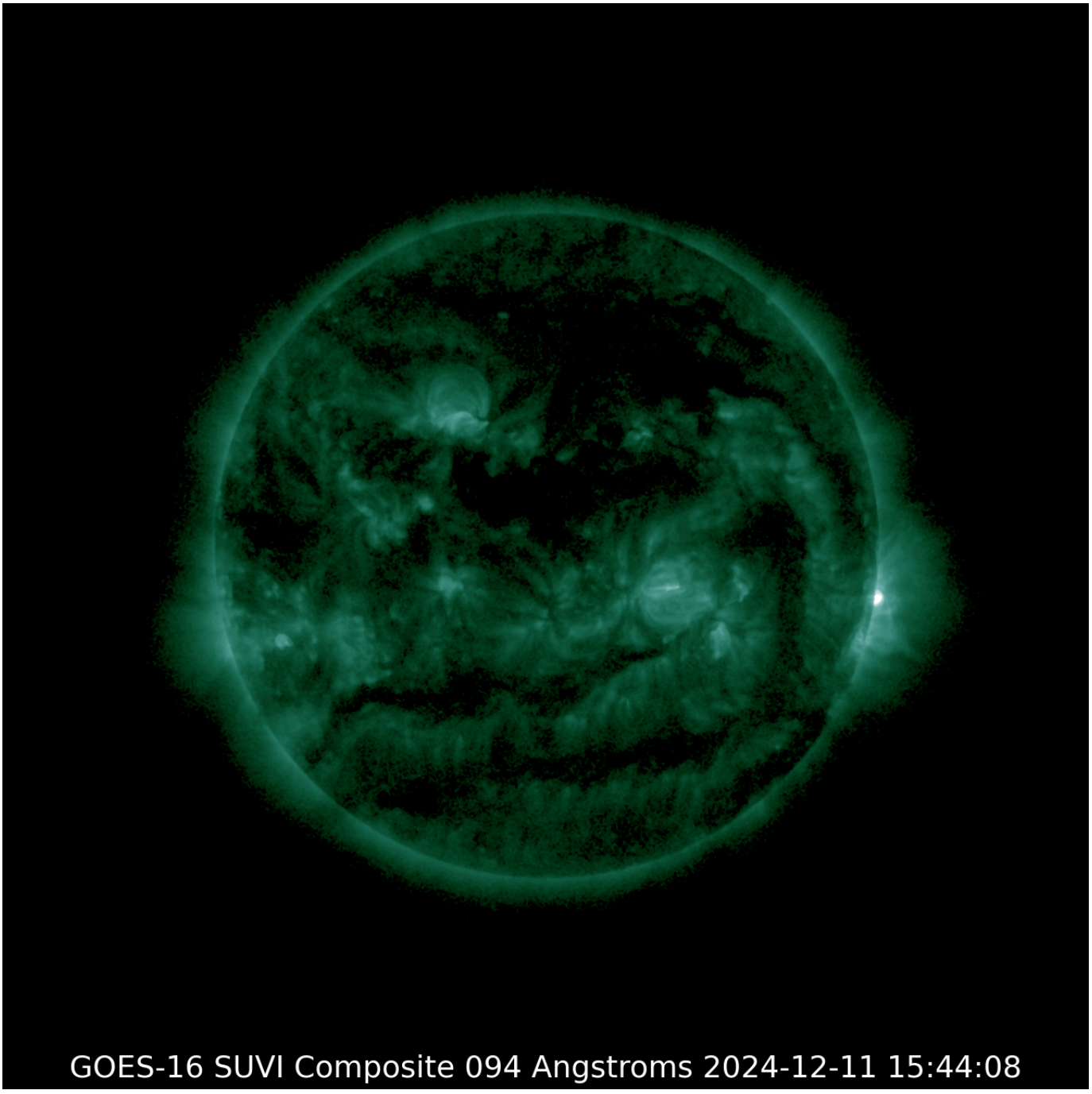
Figure 3: GOES16 SUVI 094 imagery of the M6.7 flare from offgoing Ex-AR3912 (far right of image).



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Solar Radiation Storms (High Energy Protons)

GOES18 proton flux showed no high energy response in the near-Earth environment to the M6 flare from offgoing region Ex-AR3912. While this tendency may continue, it is felt that there is a slightly raised risk from this active region's position nearing 110W above that of the front side. Any contribution from this group should soon decrease, before the more potent Earth-facing regions move sufficiently far into the better-connected western solar hemisphere to register as an increasing Slight Chance of S1 in themselves.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	5	5	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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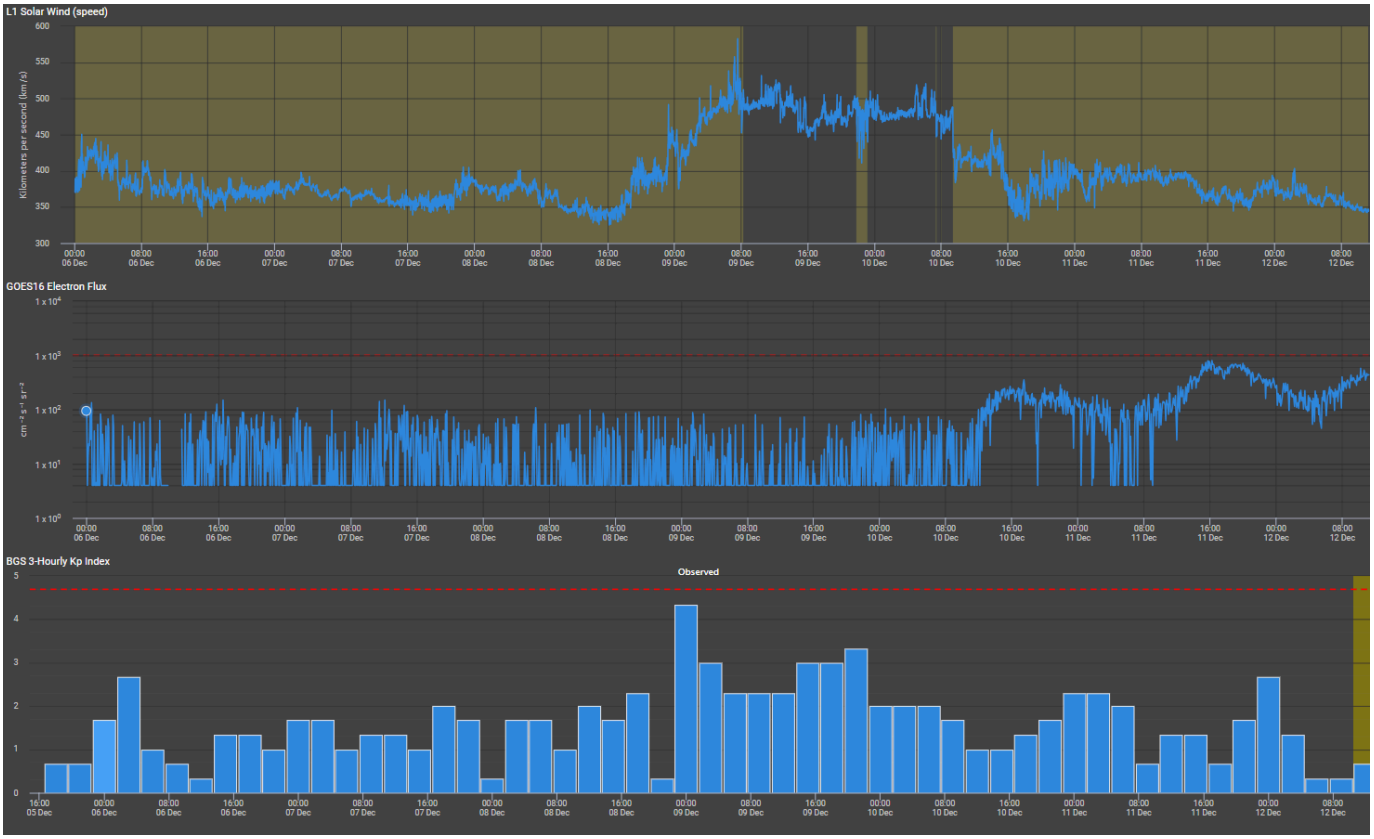
High Energy Electrons (≥ 2MeV)

The current trend in high energy electron flux should now continue in the near-term in the expected absence of any other drivers of counts in the Van Allen belts. Any arrival of the fast winds of CH99 over the UTC weekend will likely drop out values at GEO, to Normal Background, with any recovery probably not following until the forthcoming new UTC working week.

The associated 24-hour fluence is expected to remain below Active. The MOSWOC REFM forecast is currently underestimating the expected fluence, with a slight upward trend more likely, however the overall forecast for fluence is for levels to remain below Active.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	1	1	1	5
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

Figure 4: Past week in L1 solar wind conditions, showing CH98 mid-period; resulting GOES16 high energy electron flux at GEO and BGS Kp indices.



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